Joint Theater Trauma System Implementation of Burn Resuscitation Guidelines Improves Outcomes in Severely Burned Military Casualties

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Background: **Between March 2003 and June 2007, our burn center received 594 casualties from the conflicts in Iraq and Afghanistan. Ongoing acute burn resuscitation as severely burned casualties are evacuated over continents is very challenging. To help standardize care, burn resuscitation guidelines (BRG) were devised along with a burn flow sheet (BFS) and disseminated via the new operational Joint Theater Trauma System to assist deployed providers.**

Methods: **After the BRG was implemented in January 2006, BRF data were prospectively collected in consecutive military casualties with >30% total body surface area (TBSA) burns (BRG Group). Baseline demographic data and fluid requirements for the first 24 hours of the burn resuscitation were collected from the BFS. Percentage full thickness TBSA burns, presence of inhalation injury, injury severity score, resuscitation-related abdominal compartment syndrome, and mortality were collected from our database. Individual charts were reviewed to determine the presence of extremity fasciotomies and myonecrosis. These results were compared with consecutive military casualties admitted during the 2-year-period before the system-wide implementation of the BRG (control group).**

Results: **One hundred eighteen military casualties with burns >30% TBSA were admitted between January 2003 and June 2007, with n = 56 in the BRG group and n = 62 in the control group. The groups were different in age, but similar in %TBSA, %full thickness, presence of inhalation injury, and injury severity score. There was no difference in the rate of extremity fasciotomies or the incidence of myonecrosis between groups.**

Conclusions: **The composite endpoint of abdominal compartment syndrome and mortality was significantly lower in the BRG group compared with the control group ($p = 0.03$). Implementation of the BRG and system-wide standardization of burn resuscitation improved outcomes in severely burned patients. Utilization of the joint theater trauma system to implement system-wide guidelines is effective and can help improve outcomes.**

Key Words: **Burn, Joint theater trauma registry, Resuscitation, Guidelines.**

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Historically, 10% of all casualties during a military conflict involve burns. Of these, nearly 20% are categorized as severe or involving greater than 20% total body surface area (TBSA) and require significant intravenous resuscitation.[1] To prevent organ failure and death, optimal resuscitation while avoiding over-resuscitation morbidity is critical in the first 24 hours to 48 hours postburn.[1,2]

The United States Army Institute of Surgical Research Burn Center is the sole burn treatment facility in the Department of Defense serving active duty personnel in addition to its role as the regional burn center for South Texas. Since the beginning of 2003, our burn center has admitted nearly 600 military casualties sustaining burns in Iraq and Afghanistan. With one stop in Germany, military burn casualties injured in the Middle East are rapidly evacuated across three continents to our burn center in a 3- to 6-day-period. Optimal care of these patients involves not only carefully managed resuscitation, but also transfer to a facility that specializes in burn care with the goal of early surgical excision of burn wounds and definitive coverage with autograft. As such, rapid global evacuation of burned soldiers to our burn center has been a priority during this conflict. Critical advances in air-evacuation of the war wounded with the emergence of the US Air Force Critical Care Air Transport Team program in the 1990s, has made this possible by maximizing available US Air Force aircraft for patient evacuation.[3] The most severely burned

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patients are met and transported back to our burn center by the Army's Burn Flight Team at Landstuhl Regional Medical Center.

Approximately 2 years into the conflict, providers at the burn center began to observe a high incidence of resuscitation-related morbidity in evacuated military casualties. Specifically, a series of resuscitation-related abdominal compartment syndromes (ACSs) and extremity myonecroses were observed. It became clear that rapid global evacuation of burn patients, usually occurring in the first few critical hours after injury, had created a unique and challenging set of problems that required resolution to optimize care.[1]

First, the responsibility of burn resuscitation of the war wounded in the critical days immediately after injury lies on the shoulders of physicians and nurses who do not specialize in burn care and whose priorities are not focused on stabilization and evacuation to the place of definitive care. Second, the burn casualty will typically be cared for by a number of providers at multiple levels in the evacuation chain before arriving at the burn center. Variations in practice are expected. Third, documentation of care was either very poor or nonexistent, making it extremely difficult to assess and identify problem areas. Fourth, communication across various services, disciplines, and hospitals at the different echelons of care throughout the evacuation process was very fragmented. This made the identification and correction of system-wide issues problematic.

In response to the identified problem of an increased incidence of over-resuscitated patients and in an effort to help standardize care, burn resuscitation guidelines (BRG) were devised along with a burn flow sheet (BFS) to better document the resuscitation during the evacuation (Tables 1 and 2, Fig. 1).

Table 1 **Recommendations for the Difficult Fluid Resuscitation**

At 12–18 h postburn, calculate the projected 24-h resuscitation if fluid rates are kept constant. If the projected 24-h resuscitation requirement exceeds 6 mL/kg/%TBSA then the following steps are recommended.

1. Initiate 5% albumin early as described previously in the Emergency War Surgery Handbook.
2. Check bladder pressures every 4 h.
3. If Urine Output (UOP) <30 mL/h, strongly consider the placement of a Pulmonary Artery (PA) catheter to guide resuscitation with specific Pulmonary Capillary Wedge Pressure (PCWP) and Mixed Venous Saturation (SvO2) goals. (Goal PCWP 10–12, SvO2 65%–70%). If PA catheter placement is not practical then consider monitoring Central Venous Pressures (CVP) from a subclavian or IJ along with Central Venous (ScvO2) saturations. (Goal CVP 8–10, ScvO2 60%–65%).
   a. If CVP or PCWP not at goal then increase fluid rate.
   b. If CVP or PCWP at goal then consider vasopressin 0.04 Units/min to augment MAP (and thus UOP) or Dobutamine 5 mcg/kg/min (titrate until SvO2 or ScvO2 at goal). Max dose of Dobutamine is 20 mcg/kg/min.
   c. If both CVP or PCWP and SvO2 or ScvO2 at goal then stop increasing fluids (EVEN if UOP <30 mL/hr). The patient should be considered hemodynamically optimized and the oliguria is likely a result of established renal insult. Some degree of renal failure should be tolerated and expected. Continued increases in fluid administration despite optimal hemodynamic parameters will only result in "resuscitation morbidity", that is oftentimes more detrimental than renal failure.
4. If the patient becomes hypotensive along with oliguria (UOP <30 mL/hr), then follow the hypotension guidelines.
5. Every attempt should be made in minimize fluid administration while maintaining organ perfusion. If UOP >50 mL/h, then decrease the fluid rate by 20%.

After 24 h, LR infusion should be titrated down to maintenance levels and albumin continued until the 48 h mark.

Table 2 **Hypotension Guidelines**

The optimal minimum blood pressure for burn patient must be individualized. Some patients will maintain adequate organ perfusion (and thus have adequate UOP) at MAPs lower than 70. True hypotension must be correlated with UOP. If a MAP (generally <55 mm Hg) is not adequate to maintain the UOP goal of at least 30 mL/h then the following steps are recommended.

1. Start with Vasopressin 0.04 units/min drip (DO NOT TITRATE).
2. Monitor CVP (goal 8–10).
3. If CVP not at goal then increase fluid rate.
4. If CVP at goal then add Levophed (norepinephrine) 2–20 mcg/min.
5. If additional pressors are needed, consider the placement of a PA catheter to guide resuscitation with specific PCWP and SVO2 goals (goal PCWP 10–12, SVO2 65%–70%). These patients may be volume depleted but a missed injury should be suspected.
   a. If PCWP not at goal then increase fluid rate.
   b. If PCWP at goal then consider Dobutamine 5 mcg/kg/min (titrate until SvO_2 at goal). Max dose of Dobutamine is 20 mcg/kg/min.
   c. If hypotension persists, look for missed injury.
   d. Consider adding epinephrine or neosynephrine as a last resort.
6. If the patient is exhibiting catecholamine-resistant shock, consider the following diagnoses.
   a. Missed injury and on-going blood loss.
   b. Acidemia. If pH <7.20 then adjust ventilator settings to optimize ventilation (Target PCO_2 30–35). If despite optimal ventilation, patient is still has a pH <7.2, consider bicarb administration.
   c. Adrenal insufficiency. Check a random cortisol and add start hydrocortisone 100 mg every 8 hours.
   d. Hypocalcemia. Maintain Ionized Calcium >1.1.

JTTS Burn Resuscitation Flow Sheet Page 1

Date: Initial Treatment Facility:

Name	SSN	Pre-burn Est. Wt (kg)	%TBSA	Estimated fluid vol. pat. should receive 1st 8 hrs	2nd 16th hrs	Est. Total 24 hrs

Date & Time of Inury

BAMC/ISR Burn Team DSN 312-429-2876

Tx Site/ Team	HR from burn	Local Time	Crystalloid (ml) / Colloid	TOTAL	UOP	Base Deficit	BP	MAP (>55) / CVP	Pressors (Vasopressin 0.04 u/min)
	1st								
	2nd								
	3rd								
	4th								
	5th								
	6th								
	7th								
	8th								
	Total Fluids 1st 8 hrs:								
	9th								
	10th								
	11th								
	12th								
	13th								
	14th								
	15th								
	16th								
	17th								
	18th								
	19th								
	20th								
	21st								
	22nd								
	23rd								
	24th								
	24 hr Total Fluids:								

Fig. 1. *Theater-wide burn flow sheet used for standard documentation of the resuscitation.*

One year before establishing the BRG, the Joint Theater Trauma System (JTTS) was conceived through a collaborative effort of the three Surgeons General of the US military, the United States Army Institute of Surgical Research, and the American College of Surgeons Committee on Trauma.[4] The focus of JTTS was to improve coordination of care, by providing data that would address and answer operational questions, predict manpower needs, provide medical situational awareness such as injury patterns, and evaluate protection/prevention maneuvers. Data would be used to evaluate outcomes, need for training, improve continuity of care, and facilitate system-wide data driven real-time changes.[4] Somewhat fortuitously, in September 2005 a weekly videoteleconference was organized via the JTTS to allow providers throughout all echelons of care a means to communicate and provide real-time feedback discussing care and transport from point of injury to the most appropriate level of care of the critically ill.[5] This provided an additional venue to instantly disseminate important clinical pathways or guidelines. It was through this newly established communications vehicle that we were able to rapidly disseminate the information that we had identified a systems problem and intervened with the new BRG and BFS. The present study was undertaken to assess the impact of utilizing the JTTS to implement the BRG and BFS across the entire military system on the outcome of our most severely burned patients.

MATERIALS AND METHODS

The BRG was implemented and widely distributed in January 2006. BRF data were collected prospectively in consecutive military casualties with >30% TBSA burns (BRG group). Baseline demographic data and fluid requirements for the first 24 hours of the burn resuscitation were collected from the BFS. Our trauma database was used to collect percentage full-thickness TBSA burned, presence of inhalation injury, injury severity score (ISS), resuscitation-related ACS, and death. Individual charts were reviewed to record the number of extremity fasciotomies and myonecrosis. Myonecrosis was defined as dead muscle needing debridement and serum creatine phosphokinase >5000 in addition to fasciotomy. ACS was defined as a persistent pathologic increase in intra-abdominal pressure, exceeding 20 mm Hg with consecutive dysfunction of multiple organ systems requiring decompressive laparotomy within 7 days postburn. These results were compared with consecutive military casualties with >30% TBSA admitted during the 2-year-period before the system-wide implementation of the BRG (control group).

Data were analyzed using SAS, Version 9.1 (SAS Institute, Cary, NC). Comparisons were made between the BRG group and control group. Data are presented as mean ± SD. Multiple logistic regression analysis was used to determine the effect of such variables as age, % TBSA burn, % full thickness TBSA burn, inhalation injury, ISS, total fluid received, need for pressors, treatment group, and completed BFS on the risk of death. Continuous variables were compared via paired Student's *t* test. Chi-square testing was used to compare categorical variables. All testing was two-tailed, with $p < 0.05$ considered significant. Where appropriate, Phi coefficient correlation studies were performed.

Table 3 Group Comparison

	Control Group (n = 62)	BRG Group (n = 56)	*P*
Age	28 ± 8	25 ± 5	0.0213
% TBSA	50 ± 17	52 ± 17	0.5314
% Full thickness	40 ± 22	43 ± 21	0.3679
Inhalation injury	41.9%	35.7%	0.4890
ISS	34 ± 13	34 ± 10	0.9865

Table 4 Selected Outcomes

	Control Group (n = 62)	BRG Group (n = 56)	*P*
Extremity fasciotomies	68%	80%	0.1705
Myonecrosis	30%	27%	0.6439
ACS	16%	5%	0.06201
Mortality	31%	18%	0.1071
Composite endpoint (ACS + mortality)	36%	18%	0.0315

RESULTS

Between January 2003 and June 2007, 598 military casualties were admitted to the USAISR Burn Center. Of these, 118 had >30% TBSA burns; 62 before implementation of new procedures (control group), and 56 afterward (BRG group). The groups were different in age but similar in %TBSA, % full thickness, presence of inhalation injury, and ISS (Table 3). All patients were transported by air at least three times and admitted to two facilities before arrival at USAISR. The average transport time was 3.2± days with no difference between groups. There was no difference in the rate of extremity fasciotomies or the incidence of myonecrosis between groups (Table 3). As individual endpoints, the incidence of resuscitation-related ACS and mortality were clinically, but not statistically, significant (Table 4). However, the composite endpoint of ACS and mortality was significantly lower in the BRG when compared with the control group (Fig. 2).

Before the implementation of the BRG, resuscitation was documented in only 31% of patients (Fig. 3). In the BRG group, 82% had completed or partially completed BFSs (Figs. 3, 4). Compared with the control group, this represents a significant improvement in documentation ($p < 0.05$). However, multiple regression analysis did not reveal any association between completion of the BFS and survival.

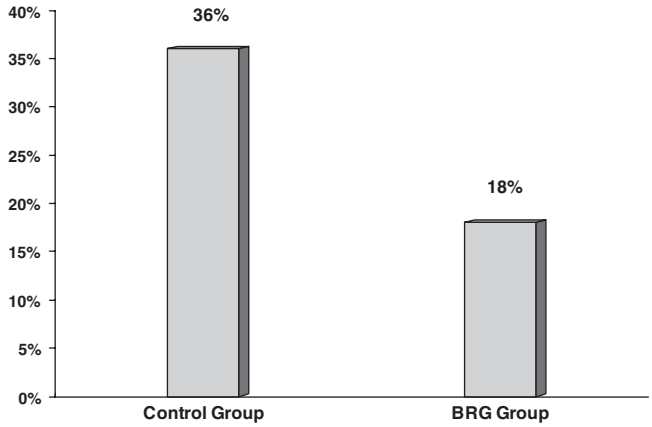

Fig. 2. *Composite endpoint of ACS with mortality was significantly lower in the BRG group when compared with the control group.*

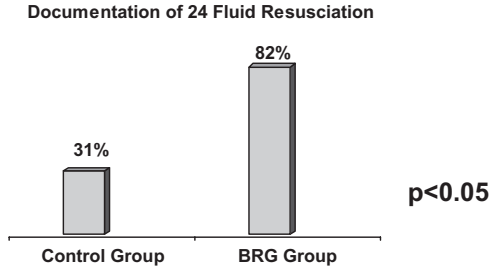

Fig. 3. *Compliance with documentation of 24 hour burn resuscitation before and after implementation of Burn Resuscitation Guidelines (BRG).*

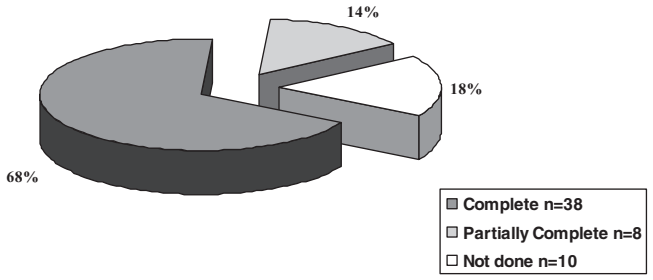

Fig. 4. *Percentage of completed 24-hour burn flow sheets (30% and greater TBSA burn admissions) for 56 patients.*

On logistic regression analysis of all patients in both groups, only %TBSA burned was associated with ACS (OR, 1.052; CI, 1.009–1.097; $p = 0.018$) and extremity fasciotomies (OR, 1.065; CI, 1.007–1.126; $p = 0.028$). Percent full thickness burn was associated with myonecrosis (OR, 1.040; CI, 1.008–1.073, $p = 0.015$). Interestingly, documented use of pressors, 48% in the BRG group and 34% in the control group, was associated with increased survival (OR, 6.309; CI, 1.466–27.137; $p = 0.013$).

We performed Phi coefficient correlation studies on just those patients who had documented 24-hour resuscitation information available in both groups (total n = 56). Of these, 22 patients (39%) received greater than 250 mL/kg of volume in the first 24 hours. Based on a previous study by Ivy et al.[6] this threshold is associated with increased incidence of ACS. Based on our data there was not a detectible association between this group and the incidence of ACS. However, there was a weak association between this group (>250 mL/kg resuscitation) and death (Phi 0.301, $p = 0.024$).

DISCUSSION

As evidenced by a significant increase in documented resuscitation, utilization of the JTTS to widely distribute BRG and BFS to help standardize care seems effective. Before and after implementation of the BRG, we observed a significant improvement in the composite endpoint of ACS and mortality. On regression analysis, however, we were not able to find an association between BFS compliance and presence of the composite endpoint. Although documentation significantly improved after implementation of our guidelines, this lack of correlation is not surprising. First, the wide distribution of the BRG and the BFS was only part of the multimodal solution to our perceived increase in resuscitation morbidity. Many other unmeasurable interventions existed during that time period.

Combat Burn Life Support classes were being taught to deploying medical personnel in 2003.[7] In September 2005, the Theater Hospital Joint Forces Combat Trauma Management Course began focusing on advanced trauma training and skills needed in theater with classes that include burn care management. The Critical Care Air Transport Team program also supplemented their training program with burn care specific training to include the new BRG and use of the BFS. It is likely that education of deploying personnel of the dangers of over-resuscitation improved overall care of the evacuating patient.

Joint Patient Tracking Application System (JPTA), a secure web-based portal, was established by JTTS at around the same period. Use of JPTA has allowed a near-real time picture of patient movement and allows authorized users the ability to view reports and see what is occurring as care is being delivered along the evacuation route. Having incorporated BRG and BFS into JPTA has allowed easy access to that information initially when it was first implemented, new burn-related treatment recommendations are added and disseminated across all levels of care. BRG and the 72-hour BFS are included in burn admission trauma packets in all emergency departments and EMT areas. We think that this arm of JTTS has been a tremendous asset in improving continuity of care and optimizing real-time communication across the echelons of care.

In March 2005, a regular rotation of burn surgeons into theater was instituted. Deployed burn surgeons act as the theater consultant for burn injuries and burn surgery. Their role not only includes treatment and burn care guidance for military forces but consultation for burn care beyond the military. They share their knowledge of burn care and educate providers of host nation war injured. In-theater burn expertise has had a tremendous impact in optimizing initial burn care for our military burn casualties.

Interestingly, on regression analysis, there was also no association between the total amount of fluids given in the first 24 hours of the resuscitation and any of the measured outcomes, including the composite endpoint. Correlation studies revealed only a weak association between a high volume resuscitation (>250 mL/kg) and death. It is likely that incomplete documentation has confounded our findings and that more accurate documentation would have strengthened this correlation. Only 68% of patients had a completely documented BFS (Fig. 3), evidence suggests that there is still room for improvement. Re-enforcement of already learned lessons through the communications vehicle provided by the JTTS and continued diligence on the part of providers at all levels of care are critical elements that will institutionalize and help to standardize care.

CONCLUSION

Utilization of the JTTS to implement system-wide guidelines was extremely effective in improving documentation and standardization of care. An improvement of the composite end-point of ACS and mortality was realized between the periods analyzed. Reasons for improvement of outcome could not be directly linked to the successful dissemination of the BRG and BFS usage. Improvement in outcome is likely the result of a multifactorial, multidisciplinary improvement in burn care during the course of the study period. Still, room for improvement exists as new providers with varied levels of burn expertise continue to rotate across all echelons of care.

The JTTS is an important avenue for the optimization and standardization of care in any specialized field in the care of the combat wounded.

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DISCUSSION

Dr. Jay Johannigman (Division of Trauma and Critical Care, University of Cincinnati, Cincinnati, OH): I would like to thank Colonel Holcomb and the program committee for the opportunity to review this significant work that continues the proud legacy of the US Army's Institute of Surgical Research and its burn center. I would also pause a moment to recognize the selfless sacrifice of all the deployed military medics from all three services that contributed to this work with specific mention of the nurses and enlisted personnel who are the "tip of the spear" responsible for the first care of these wounded soldiers.

With the privilege of the podium I would like to make a general observation before proceeding to some specific comments and questions for the authors. I think that the true importance of this work is the demonstration of the utility of the military medical corps implementing a trauma system in the theater. Like any other trauma system this one requires the incorporation of many facets that include, but are not limited to the following . . .

a. Appropriate leadership—this may be the first conflict where the military medical system has been able to fully employ the lessons learned and then taught by the American College of Surgeons and the Committee on Trauma and its Verification Review Committee. The ACS COTVRC has changed the scope and manner of care for trauma patients in the United States and the important lessons they have garnered regarding system development are being appropriately implemented in this conflict. This requires that the military medics responsible for the conduct of care have the appropriate trauma training not only with respect to clinical care but also for system implementation. I note that a majority of the authors have served in or completed fellowship training at ACS trauma centers.
b. Coordinated evaluation of clinical data and recognition of potential areas of process improvement. In this instance the recognition was of the concern for possible inappropriate volume of fluid resuscitation.
c. An appropriately constructed tool for data capture at the point of care. This is the role of the Burn Resuscitation Flow Sheet and the Joint Patient Tracking Application. Both of these tools are new and were developed as a dynamic response to perceived problems with the current system of theater care. Again, my congratulations to the medics who are continually striving to improve the system of care (and to the line leadership willing to allow them to implement these changes in a timely fashion).
d. A robust data registry. In my estimation the most important decision made before this conflict began was to invest and develop the Joint Theater Trauma Registry (JTTR). This is the first military conflict where real time data can be gleaned from a registry tool and used to implement change. My congratulations to Colonel Holcomb, Dr. Howard Champion, the ISR and many others who were responsible for this truly significant decision.
e. Local leadership and open communication at the FST, EMEDS, CSH level that promotes feedback and discussion of means of improvement. This is where the weekly Video Teleconference (VTC) is so important. It is truly mind boggling to be in a tent in central Iraq and participate in a robust Morbidity and Mortality conference that spans the globe from Afghanistan to Iraq via Germany and then to the MTF in CONUS.

It is my fervent hope that at the conclusion of this conflict we place the lesson(s) learned regarding the value of system building at the top of the list of tools to be saved.

I will now attempt to direct my comments to more specific questions for the authors of this work.

1. In the introduction you note that one of the motivating factors for the development of the Burn Resuscitation Guidelines (or BRG) was the sense that patients were being over-resuscitated. Could you provide more specific data in the results or tables that compare the weight-based volume of crystalloid resuscitation that each group received? In the discussion section you briefly comment on the fact that there was no association between the total amounts of fluids given in the first 24 hours of resusci-

tation and any of the measured outcomes. You also note that there was a weak association between high-volume resuscitation and death. I think that in the final work this would be important information to include in the tables and to discuss a bit more fully. I believe you correctly note the challenges of incomplete documentation in a combat environment and that even after BRG and BRFS implementation documentation was available in only 68% of the cases. This begs for the development of automated system(s) to help us account for these important data points without increasing the burden to the caregiver in the field.

2. The chosen endpoints of abdominal compartment syndrome and mortality fall just short of being statistically significant. This is an instance where rigorous scientific analysis should yield to the common sense pragmatism of the clinician. This system works—and works well to reduce the incidence of abdominal compartment syndrome and mortality. Perhaps the authors should revisit their analysis with the benefit of an additional year of data—I would be willing to bet a few beers that the endpoint of significance is there.
3. You chose abdominal compartment syndrome as a surrogate marker of fluid over-resuscitation. I agree that this is an appropriate marker but how about other manifestations of aggressive fluid administration? Specifically, one endpoint that should be trackable would be length of time for mechanical ventilation. Pulmonary dysfunction as a result of aggressive fluid administration may be monitored in this fashion. Would your data set be able to compare the length of time for mechanical ventilation in these two groups?
4. Did you consider eliminating patients with lethal TBSA injuries? I would leave it to the authors and their considerable burn experience as to where this threshold should be (>90%?). As the battlefield becomes increasingly lethal it would be important to use this as a means of validating the similarities between the two groups before proceeding to a mortality analysis.
5. I was intrigued by the finding that the documented use of vasopressors was associated with an increased survival in both groups. I suspect from personal experience at Balad that this actually is the use of vasopressin (rather than dopamine). Could the authors comment more on this finding and spend a bit more of the discussion on this aspect? I think this is an important finding. I am not familiar enough with the burn literature to understand if this is the first article to note this association but I would speculate that this may be that largest number of patients in such a comparison.

As a final comment, I am concerned that the casual reader will conclude that the volume of crystalloid a burn casualty receives in the first 24 hours does not change outcome and stop right there. The value of this article is that it demonstrates that a step-wise approach to resuscitation of the combat burn patient improves outcome. This includes appropriate establishment of preload, the monitoring of preload via CVP or PCWP, the use of vasopressors in the appropriately volume-loaded patient and the tolerance of oliguria in certain clinical settings. This article also demonstrates that a theater-wide system of care monitored by a dedicated team of medics can dynamically improve the outcome for our wounded warriors. That is what it is all about.

Dr. Jody L. Ennis (US Army Institute of Surgical Research, Fort Sam Houston, TX): Our discussion has been modified to address many of the issues identified. Despite the improvement realized in the composite endpoint in our study, we would like to emphasize that there is significant room for improvement. Documentation, although much upgraded from one period to the next, continues to be an issue. We noted only 68% of patients who required a BFS had a completed BFS after it was implemented in January 2006. Logistic regression analysis did not reveal a detectible association between the use of BFS with any of our endpoints. Similarly, there was no detectible correlation between total volume infused in the first 24 hours and any of our resuscitation-related endpoints. These shortcomings are likely a result of the incomplete documentation or the relatively small sample size of our study. We sincerely hope that readers will not conclude that fluid volumes are unimportant. As Dr. Johannigman forecasts, these relationships will become more evident as we gather more data. With much room for improvement, perhaps other solutions, such as autonomous controllers or decision support systems, may be needed to aid in capturing accurate data without placing the documentation burden on our deployed providers. Clearly, more work is needed in this area. We agree that the real strength of this article is to point out that a step-wise approach in the resuscitation of combat wounded is what can lead to improved outcomes using the BRG and BFS as a guide. Furthermore, the JTTS has provided an important avenue in which any provider in any specialty can identify a problem within the system and rapidly disseminate a proposed solution to all levels care. We have demonstrated its ability to help providers adapt and change practice for the better. As the combat casualty care environment continues to evolve, we are certain that this well-grounded infrastructure will have a lasting impact.